

APPLICATION
FOR
UNITED STATES LETTERS PATENT

TITLE: **FULLY AUTOMATED VEHICLE DISPATCHING,
MONITORING AND BILLING**

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FULLY AUTOMATED VEHICLE DISPATCHING, MONITORING AND
BILLING

Field of the Invention

5 The present invention relates to
dispatching or controlling of taxis, ambulances, or
other vehicles.

Background of the Invention

10 A number of systems have been devised for
dispatching of vehicles or other services upon
demand. The complexity of dispatching systems
ranges from fully manual systems to systems
employing elaborate computer databases and tracking
systems.

15 To dispatch vehicles accurately and in a
timely fashion, several things must be done
concurrently. Vehicles must be tracked so that
their location is known so that they may be
efficiently selected for future jobs. The position

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and status of dispatched vehicles must be monitored to determine if they are on time or delayed.

Customer requests must be received and posted for dispatching, and then dispatched. Delayed arrivals should be identified and reported to the customer as soon as possible.

A fully manual dispatching system (such as is employed by smaller taxi companies), requires a single human being to perform all of the tasks identified above. More modern dispatching systems provide automation of some of the described tasks.

For example, various systems have been established to manage the reception and posting of customer requests. For example, the "Life-TRAK" system, available from the assignee of the present application, provides a database server storing a database of customer request records. New records are generated by call takers who receive incoming telephone calls from customers. Also, records may be generated at remote sites, for example by contract customers, and transmitted into the central database by telephone connections. The customer requests are then reported to dispatchers who determine when the requests are in need of service, and dispatch a vehicle as needed.

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There are also commercially available systems for assisting the dispatching tasks described above. For example, there are commercially available Automatic Vehicle Locator (AVL) systems which automatically track (typically via satellite navigation) the locations of managed vehicles, so that this information can be reported to a dispatcher in textual or graphic form to assist the dispatcher determining the locations of vehicles. Typically, the dispatcher uses this information to select a vehicle for a particular job, and then forwards instructions to the driver to assign them the job. Often, the AVL includes data fields where the dispatcher may store an indication of the status of a vehicle (e.g., dispatched or available) and the vehicle's capabilities (e.g., wheelchair-compatible, etc.) so that this information can be used by the dispatcher in selecting a vehicle for a job and monitoring activity of the vehicles.

Advanced AVL systems further facilitate dispatching, by automatically identifying, upon request, the nearest vehicles to a given address or latitude/longitude position, to assist the dispatcher in selecting a vehicle for dispatch.

Furthermore, AVL systems may also include a street map database and search algorithm through which the AVL can identify a street route from one address to another upon request from the dispatcher.

5 In some cases, the dispatcher communicates
with the vehicles via radio communication or
cellular telephone connections. In other cases, the
AVL system itself includes support for textual
communication between dispatchers and the vehicles
0 through mobile data terminals (MDT's) mounted in the
vehicle, which typically make use of underlying
cellular communication networks.

Summary of the Invention

Despite the high degree of automation that
15 has been applied to vehicle dispatching, as
described above, one common thread between fully
manual dispatching and the most automated
dispatching systems is their central reliance on
human beings to make dispatching decisions and
20 perform monitoring of vehicles once dispatched.
Unfortunately, it has been found that a primary
source of errors, in even the most automated
dispatching systems, is human error. For example, a
dispatcher may misread customer job request and fail
25 to dispatch it on time. Or the dispatcher may

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forward a dispatch to a vehicle through a MDT but fail to follow up and ensure that the MDT message has been acknowledged by the vehicle driver and that the vehicle is en route, causing the vehicle to arrive late, or not at all. Or, in the case of taxi or ambulance/ambulette dispatching, the dispatcher may through inadvertence assign a taxi which is not wheelchair-equipped to a job which requires a wheelchair-equipped vehicle, or assign an ambulette (wheelchair ambulance) to a job which requires a stretcher ambulance, resulting in wasted time and/or delay for the customer. Or special instructions relating to the customer, route, or other items may fail to be forwarded to the vehicle.

It is the object of the present invention to overcome these shortcomings in known vehicle dispatching systems by providing a fully automated dispatching system which, at least under normal operating conditions, eliminates the human dispatcher from dispatching operations. The elimination of human errors of the kind described in the previous paragraph greatly improves the consistency of service provided to customers and improves the likelihood of repeat requests.

In one specific aspect, the invention features a system for controlling vehicles to provide transportation services without need for human intervention, including a database of records each documenting needed transportation services. This database is reviewed by processing circuitry to locate records indicating a need for immediate transportation service, and then instruct vehicles to provide the vehicle service. In addition, the processing circuitry monitors the records after dispatching, along with vehicle activity information, to identify transportation services which are not being adequately provided. The processing circuitry is in continuous automatic communication with the vehicles, forwarding instructions to vehicles and obtaining vehicle activity information relating to each vehicle.

The processing circuitry may be a microcomputer running a multitasking operating system, a network of computers, or any other arrangement of computing hardware, including an arrangement of computers spread geographically in a wide-area network. There may be multiple processes to dispatch and monitor vehicles, running

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simultaneously on networked computers or in a multitasking operating system.

5 The vehicle communications may use ground-based radio communication, satellite-based radio communication, or both. In particular, satellite-based vehicle tracking circuitry may be used to track the locations of the vehicles, and the vehicle locations forwarded via satellite or radio to the processing circuitry for using in vehicle
10 monitoring.

The vehicle monitoring may evaluate the vehicle's movements and position to determine if it has arrived at or is en route to an appointed location. Alternatively, or in addition, the
15 vehicle operator may manually communicate the arrival of the vehicle at the appointed location.

Requests for vehicle service may be entered by call takers at the location of the database server, or may be entered remotely via
20 telephone, either at a data terminal at a customer site or via touch-tone telephone or at an ATM-like facility using a customer identification card.

When the automated dispatching and controlling system finds a task which is not being
25 adequately serviced, and cannot rectify the

situation, the system creates an exception records to refer this situation to a human dispatcher who then may take extraordinary action with respect to the situation.

5 The automated dispatching and controlling system not only collects vehicle appointment and activity information, but also collects billing information associated with requested transportation services, for example, in an ambulance environment, 10 the patient name, diagnosis, reason for transit, insurance information, etc. When a task is completed, this information is used to automatically, and without further human involvement, generate paper or electronic invoicing 15 for the services rendered.

 The system may also be used to monitor use of the vehicles, e.g., whether the vehicle is moving, the velocity of the vehicle, whether the vehicle is braking, fuel usage of the vehicle, 20 whether emergency signals of the vehicle are operating, and whether the engine is idling. This information can be used to determine, in a more detailed manner, the status of the vehicle, e.g., whether it is stalled in traffic, or whether the 25 vehicle is being used inappropriately. In either

case, an exception record can be generated to refer the situation to a human dispatcher.

The collection of information on current vehicle status and future appointments can be combined to provide continual, automated system status management, to determine and predict future needs for transportation services and compare the future needs to expected availability of transportation services. If this process identifies future times at which available transportation services will not meet predicted needs, this situation can be referred to a human dispatcher ahead of time so that corrective action can be taken. Alternatively, or in addition, the system may automatically instruct a vehicle to pre-position to a location where the vehicle will be better able to meet predicted future needs for transportation services, to minimize future delays.

An important feature of the automated dispatching system is that a dispatching process instruction to a vehicle identifies a route to be followed by the vehicle. This feature will be increasingly important in the future when governmental or insurance entities may begin to demand particular routing, or at least identify

maximum mileages that will be reimbursed. By ensuring vehicles follow pre-defined routing, these requirements can be more easily met.

Indeed, it is expected that the ability to
5 automatically generate routes, and to automatically
provide them to vehicles, in accordance with the
present invention, will heighten awareness of
mileage charges and result in a demand for systems
to review mileage charges (no matter how generated)
10 and compare the mileage charges to the mileage for
an optimal routing. Such a system might be used by
an insurance or governmental agency to locate
excessive mileage charges, or used by a transit
company to pre-screen invoices before they are
15 rejected by an insurance or governmental agency.
Accordingly, the present invention encompasses
systems which make use of existing AVL technology to
compute routing and mileage based on invoiced pickup
and destination sites, and then compare the mileage
20 of the computed route to the mileage charged in the
invoice.

The above and other objects and advantages
of the present invention shall be made apparent from
the accompanying drawings and the description
25 thereof.

Brief Description of the Drawing

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with a general description of the invention given above, and the detailed description of the embodiments given below, serve to explain the principles of the invention.

Fig. 1 is a functional block diagram of a fully automated vehicle dispatching, monitoring and billing system in accordance with principles of the present invention;

Fig. 2 is an illustration of the various data files stored by the server in Fig. 1 and manipulated by the automated dispatching, monitoring and billing system;

Figs. 3A, 3B, 3C, 3D, 3E, 3F, 3G, 3H, 3I, 3J and 3K are illustrations of the formats of the data files illustrated in Fig. 2;

Figs. 3K-1, 3K-2, 3L-1, 3L-2, 3M-1, 3M-2, 3N-1, 3N-2, 3O-1, 3O-2, 3P-1, 3P-2, 3Q-1, 3Q-2, 3R-1 and 3R-2 are illustrations of the automated dispatch messages and responses exchanged between the AVL system and automated Communications, Dispatching and Vehicle Monitoring processes illustrated in Fig. 1;

Figs. 4A and 4B are flow charts of the operations performed by a Dispatching process of Fig. 1;

5 Fig. 5 is a flow chart of the operations performed by a Vehicle Monitoring process of Fig. 1; and

Figs. 6A and 6B are flow charts of the operations performed by a Communications process of Fig. 1.

10 Detailed Description of Specific Embodiments

Referring to Fig. 1, a fully automated vehicle dispatching, monitoring and billing system in accordance with the principles of the present invention, includes several elements for automated
15 dispatching and monitoring which have been discussed above in the background of this application. Specifically, the system includes a database server 10 for storing records indicating requested vehicle services and associated information. This database
20 is created initially at one of two data entry sites 12, 14. Call takers 12 located at the dispatching facility (multiple call takers being illustrated in Fig. 1) receive telephone requests from customers such as customer 13 and, in response, generate
25 request records in the database in several tests.

Contract customers 14 may also possess remote data entry terminals at which the customers may enter data into database server 10 over a telephone connection 15.

5 Incoming requests may also be accepted by various other methods; for example, remote facilities may enter information over a radio, or satellite, or Internet, or other communications links rather than telephones. Furthermore, requests
10 may be entered through touch tone dialing at a touch tone telephone in a manner analogous to that ^{currently} ~~current~~ used for telephone banking. Another alternative is that requests may be entered at remote kiosks similar to automated teller machines, using health
15 insurance or identification cards issued to customers.

The dispatching facility also includes a number of human dispatchers 16 who interact with data in the database 10 to dispatch vehicles.
20 Dispatchers 16 may interact with the database and server 10 and an AVL system ¹⁸ ~~16~~ to perform dispatching of vehicles 20 in the same manner as is performed in known dispatching systems as discussed above. Particularly, dispatchers 16 may review
25 request records in database server 10, and in

response to these records interact with AVL system
18 to request vehicle location information and
routing information and to relay dispatching
commands and request status updates from vehicles
5 over wireless communication links 22.

In known dispatching systems described in
the background of this application, this kind of
interaction between database server 10 and AVL
system 18, using human dispatchers 16, is the
10 primary and only mode of operation. However, in
accordance with the principles of the present
invention, this human-based mode of dispatching is
used only in extraordinary circumstances. Under
normal circumstances, the interactions with database
15 server 10 and AVL system 18 are fully automated and
are performed by communications processes 24,
dispatching processes 26 and vehicle monitoring
processes 28, which automatically dispatch and
monitor vehicles in response to orders reflected in
20 records and database 10.

In accordance with this new and unique
model for dispatching of vehicles, dispatchers 16 do
not constantly interact with database server 10, AVL
system 18, and the vehicle drivers, but rather only
25 interact with the drivers and other systems when

extraordinary circumstances require human
intervention into the automatic dispatching provided
by processes 24, 26 and 28. This infrequent
interaction with the AVL system 18 and server 10 is
5 represented by dotted lines 17 and 19 between
dispatchers 16, AVL system 18 and database server
10.

Under normal circumstances, as will be
explored more fully below, dispatchers 16 have an
10 only supervisory and monitoring role. Dispatchers
may, for example, monitor vehicle activities and
dispatching to ensure the system is operating
properly and perhaps to override automatic
dispatching decisions which are obviously erroneous
15 or should be handled differently for policy reasons.
Furthermore, dispatchers might update vehicle status
information based using intelligence gained from
outside the automated dispatch system. However,
although dispatchers 16 ~~they~~ may perform various
20 monitoring of this kind and may occasionally
override automated dispatching, dispatchers 16 will
typically only become actively involved in a given
dispatching transaction when the automated
dispatching processes 24, 26 and 28 identify an
25 exception requiring human intervention and a

corresponding exception record is placed into
database server 10.

Exception records are immediately reviewed
by dispatchers 16, who may then interact with the
5 AVL system 18 to determine the location of the
vehicle, and/or may communicate with the driver
through the AVL system (in the manner described
below) or through a radio, cellular phone, pager, or
satellite communications to determine the cause of
10 the exception and resolve the exception.

The following figures and description
provide a detailed elaboration of the specific
operations of the communications processes 24,
dispatching processes 26 and vehicle monitoring
15 processes 28 to automate the previously manual,
human-based operations of the dispatchers 16 to
permit the dispatchers to focus on exceptional
situations.

As an initial matter, it will be
20 understood that the software for performing the
remaining tasks illustrated in Fig. 1, such as the
local and remote call taking and data entry,
dispatcher record monitoring, automated vehicle
location and vehicle communication, can be one of a
25 number of commercially available software packages

for vehicle dispatching, including, for example, the
above-noted "Life-TRAK" software which is
particularly suited for dispatching of ambulances.
The file formats and software flowcharts described
in detail below are particularly suited for
incorporation into the existing commercially-
available "Life-TRAK" system which is available from
the assignee of this patent application.

The software used in "Life-TRAK", and the
additional software components described below, are
preferably written in a source code language
providing easy transport between computing
platforms. One particularly suitable source code
language is BBx Business Basic, sold by Basis
International of Albuquerque, New Mexico. This
language provides portability of source code between
any one of (a) a PC/DOS/Windows/Windows95 standalone
or Novell Netware server environment using BBx for
DOS/Novell; (b) a Unix network using serial
terminals using BBx for Unix (SCO/AIX/Etc.); (c) a
Windows for Workgroups environment with or without a
Windows NT server using BBx for Windows for
Workgroups. Furthermore, using the BBx TCP Data
Server software, any or all of the above can be
connected in a wide-area or Internet network.

Suitable Automatic Vehicle Locator systems can be purchased from various vendors including DCS, Inc., Teletrak, American TriTech, and EAI; these AVL systems either include low-level communications protocols of the kind illustrated below in Figs. 3K-1 to 3R-2 or will revise their AVL systems to support such communications.

It should be noted that a system other than the AVL may be used to support the communications between the dispatching systems and the AVL; for example, there are presently being introduced satellite paging-response systems which permit two way communications between mobile pagers and a central office via direct satellite communications. These systems could be used to transmit and receive the information discussed below in Figs. 3K-1 to 3R-2.

It is contemplated that a given automated dispatching system may include multiple communications processes 24, dispatching processes 26 and vehicle monitoring processes 28, running independently in networked computing systems. Thus, Fig. 1 illustrates a multiplicity of each process active in the automated dispatching system. The source language used for programming this system

must include facilities for locking individual database records for a multiprocessing environment -- such record locking is provided by the BBx Business Basic language described above. In the following discussion, the flow charts and operations of each of the communications, dispatching and vehicle monitoring processes will be elaborated with an understanding that multiple processes may be in simultaneous operation at any given time and processing dispatching records in server 10 simultaneously. It will also be understood that human dispatchers 16, because they are freed from most dispatching tasks, will monitor the overall operation of the automated dispatching system and determine whether a "bottleneck" has occurred at any of the communications, dispatching or vehicle monitoring phases of operations, and if so may initiate additional ones of processes 24, 26 or 28, respectively, to provide added computing time to the task which is experiencing a bottleneck.

It is further contemplated that various aspects of the automated dispatching system may be separated physically from one another; so, for example, database server 10 may be at a geographically central location whereas AVL systems

and computing systems running processes 24, 26 and 28 may be remotely located and communicating with database server 10 over a wide-area or Internet network through the above-described communications facilities. Other possible combinations of physical locations of the various components illustrated in Fig. 1 are contemplated and within the scope of the present invention.

It will be further appreciated that manual dispatching (such as that which is facilitated by the above-noted "Life-TRAK" system) may be performed in one area using server 10 while automated dispatching is performed in another area. Or, manual and automated dispatching may be performed simultaneously at the same area, or finally automated dispatching may be halted and all dispatching performed manually by dispatchers 16.

Now turning to Fig. 2, the various data files used by automated dispatch processes 24, 26 and 28 to perform automated dispatching of vehicles can be elaborated. The dispatch file 30 is the primary file used by the automated dispatch processes to store information regarding a job and the status of a vehicle assigned to a job and to

interact with other processes in the dispatching system.

5 The exceptions file 32 contains pointers to the records in the dispatch file which cannot be handled by the automated dispatching processes 24, 26 and 28, and must be managed by human dispatchers 16, as well as an indication of the reasons for why the dispatch record requires human intervention. Software controlled by human dispatchers 16 reviews 10 the exceptions file 32 to locate dispatch records requiring human intervention, so that the dispatcher 16 may evaluate the reasons for the exception and eliminate the problems encountered during automated dispatching. Once this is done, the human 15 dispatcher may re-initiate automated dispatching and monitoring for that record.

Invoice file 34 contains information for generating an invoice for the activities performed by vehicles 20 upon customer request. Invoice files 20 34 contain detailed information used to generate detailed invoices of the kind needed, for example, for federal and state Medicare and Medicaid agencies. As will be noted in detail below, the automated dispatching system has as a primary 25 feature the automated collection of invoicing

information so that this information is readily available for generation of invoices without further human involvement.

5 Vehicle file 36 and employee file 38 are used to search and identify particular vehicle jobs and particular vehicle operators, as discussed below.

10 Employee pager file 40 and pager service file 42 are used to page vehicle operators to alert the operators of new dispatching commands being transmitted to the vehicle.

15 Automated dispatching requests file 44 and automated dispatching responses file 46 are used by communications process 24 to record and maintain communications between database server 10 and AVL system 18 in order to facilitate dispatching and vehicle monitoring operations being performed by dispatching process 26 and vehicle monitoring process 28.

20 Automated dispatch setup file 48 and status limit file 49 are used by dispatching process 26 and vehicle monitoring process 28 to determine the desired behavior of these processes during dispatching and monitoring of vehicles, as
25 elaborated below.

Figs. 3A through 3R-2 illustrate specific file and data communications formats used in one embodiment of the present invention to generate and update the files illustrated generally in Fig. 2.

5 Specifically, Fig. 3A illustrates the format of records in dispatch file 30. Fig. 3B illustrates the format of records in invoice file 34. Fig. 3C illustrates the format of records in outbound vehicle file 36. Fig. 3D illustrates the format of
10 records in employee file 38. Fig. 3E illustrates the format of records in employee pager file 40. Fig. 3F illustrates the format of records in pager service file 42.

Fig. 3G illustrates the format of records
15 in automated dispatch requests file 44. Each of these records includes a message packet key code, and a unique record identifier. The message packet key code indicates the particular type of message that follows, e.g., a closest vehicle request (Fig.
20 3K-1) has a record key code of 01, and a route request (Fig. 3L-1) has a record key code of 10, etc. The record identifier is used to distinguish each record from other records of the same type which may be found from time to time in the requests
25 file 44. The record identifier is generated from a

combination of the ID number of the terminal (or
process identifier of the process) generating the
request, and transport ID number (which uniquely
identifies the dispatch record for which the request
5 is made) and a unique sequence number generated by
the process 26 or 28 which generated the request.
The key code and record identifier are followed by a
message packet which can take one of a variety of
formats. The specific formats, and their purposes,
10 are illustrated in Figs. 3K-1, 3L-1, 3M-1, 3N-1, 3O-
1, 3P-1, 3Q-1 and 3R-1, and will be elaborated
below.

Fig. 3H illustrates the format of records
in automated dispatch responses file 46, which are
15 similar in general form to the requests in file 44.
Each automated dispatch response record includes a
message packet key code and record identifier,
followed by the message packet which may take one of
a variety of formats. The formats of the message
20 packets that may be included in an automated
dispatch response record are shown in Figs. 3K-2,
3L-2, 3M-2, 3N-2, 3O-2, 3P-2, 3Q-2 and 3R-2, and
will be discussed below.

Fig. 3I illustrates the format of records
25 in automated dispatch setup file 48. Fig. 3J

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illustrates the format of records in the exceptions
file 32, and Fig. 3K illustrates the format of
records in the status limit file 49.

5 The use of the files illustrated in 3A -
3R-2 will be illustrated in further detail below in
connection with Figs. 4A - 6B. Initially, it should
be noted that dispatch file records are generated by
data entry call takers 12 or remote data entry
terminals 14, as part of requesting a vehicle
10 service. When the data entry person at a terminal
12 or 14 creates the dispatch record, the terminal
or server through which the person 12 or 14 is
interacting generates a dispatch record of the
format shown in Fig. 3A, and stores this record into
15 database server 10.

When a dispatch record is created, the
data entry person indicates the customer for whom
the services have been requested. This information
is used to create the transport ID number, which is
20 the first field of the dispatch record. The
transport ID number is created by retrieving a code
for the customer and appending to this code a
sequential number. Accordingly, all of the dispatch
records for a given company will have the same
25 initial digits in their transport ID numbers. This

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is significant because the dispatch file 30 is
sorted in accordance with transport ID numbers by
database server 10, such that those records for a
given company will appear sequentially within
5 dispatch file 30 and exception file 32.

When a dispatch record is initially
created by a data entry person 12 or 14, the status
flag field of the dispatch record is set to a " "
character indicating that the dispatch job is
10 prescheduled, i.e., has not yet been dispatched but
has been requested.

The data entry person 12 or 14 also enters
the required date of service and appointment time at
which vehicle service is desired. This information
15 is stored respectively in the third and fourth field
of the dispatch file record. The appointment time
may be entered in military time format, or, if
service is requested immediately (such as is the
case with "911" ambulance service), the appointment
20 time may be entered as "ASAP", indicating that
pickup is desired as soon as possible.

Where a particular appointment time has
been identified, the data entry person 12 or 14 may
indicate a lead time for the appointment, which is a
25 request that the vehicle be allotted additional time

longitudes, and lead times, indexed by codes that may be entered by a data entry person 12 or 14.

The data entry person 12 or 14 also identifies particular information for the transport service. Specifically, the type of transport is indicated in the sixth field. The transport type may indicate any special requirements for the transport, depending upon the particular application. In the case of ambulance dispatch services, the transport type may indicate wheelchair or advanced life support, respectively indicating that an ambulette (a wheelchair-configured ambulance) can be used, or that an ambulance equipped for advanced life support is required.

For ambulance service in particular, it is useful to fill out other fields at the time the dispatch record is created by a data entry person, such as the reasons for the transport (fields 24-27), a patient ID number for indexing patient-specific information from a patient information file (not shown), the name of the caller or customer who requested the transport (field 29), the contract number if a contract customer is requesting the services (field 30), and codes for accessing additional files for billing information, such as

the base rate, mileage rate, extra services rate,
and billing address. This detailed billing
information is particularly useful in an ambulance
dispatching environment due to the level of detailed
5 invoicing needed to satisfy health insurance and
Medicare/Medicaid requirements to obtain
reimbursement. By incorporating this information
into a dispatching record at initiation, this
information can be readily moved into an invoicing
10 record after the task is completed and used for
accurate and rapid billing for services without
further human involvement.

The dispatch record also includes a number
of fields (fields 16-23) for tracking the vehicle
15 activity. These fields are filled out as the
vehicle performs the desired task. This information
is also extremely important for customer invoicing
due to insurance and Government requirements, and
therefore is also transferred to invoice records
20 upon completion of the task. To start the process
of collecting data for later use, at the time the
dispatch record is initially created, the time of
the call is recorded in field 16 of the dispatch
record.

the time that the crew of the vehicle was notified,
the time that they were dispatched with the specific
instructions, the time that they responded and
indicated that they were en route, the time that
5 they arrived at the pickup site or scene, the time
that they were en route to the destination, the time
that they arrived at the destination, the time that
they completed their task and reported themselves as
available. In addition, the automated dispatch
10 processes 24, 26 and 28 will fill in the vehicle
identification number and the driver and attendant
employee numbers in the fields 7-9 of the dispatch
record. As a result, all of this information is
available to generate detailed invoices for delivery
15 to the customer of sufficient detail to satisfy
federal and state Medicare and Medicaid authorities.

It will be noted that the dispatch
records, which accumulate over time, include
sufficient information to collectively determine the
20 movements of each vehicle throughout each business
day. Accordingly, these records can be collectively
analyzed to determine the extent to which vehicles
are being properly utilized and to potentially
develop and revise marketing and vehicle positioning
25 strategies for optimizing performance. Furthermore,

these records may be used to generate detailed reports of nearly every format indicating the utilization of a particular vehicle, the on-time performance of a particular driver or crew, and any other kind of reporting information that management may seek in order to understand and improve operation of the dispatching operation. The analyses available through dispatching record are substantially more detailed and comprehensive than those that are supplied by AVL systems, since the AVL system can only rely on stored records of vehicle movements and cannot couple these to records of customer requests and response times, customer characteristics, and all of the other information available in dispatch files.

It should also be noted that, in accordance with the invention, a single database server contains both the information on current vehicle positions and status, and information on future appointments for vehicle use. Because this information is collected in a single server, for the first time it is possible to perform status management procedures, to predict future needs for vehicles and prepare for those needs, by combining the present vehicle position and status information

alternatively in evaluating the amount of work that has been done by a given vehicle and the paths followed by the vehicle during a given day.

Another file of note is the employee file 38, the format of which is seen in Fig. 3D. This file contains records, each of which indicates the ID number and the employee's name. This file is useful for displaying employee names when a dispatcher 16 must handle an exception condition which has been identified by the automated dispatch. Furthermore, this file may be used when generating invoices to indicate employee's names rather than their ID numbers.

The automated dispatch setup file 48, records of which are illustrated in Fig. 3I, indicates setup parameters for the automatic dispatch processes 24, 26 and 28 on a company-by-company basis. The use of this file permits the automated dispatch system to provide different performance or different behaviors for different companies who request vehicle services from the automated dispatching system. Each record includes the company code of the company for the settings in the record. And the second field includes a dispatch advanced action setting, which is a time in

minutes that the automatic dispatch system uses to determine when a vehicle should be dispatched for an appointment, as discussed below in connection with Fig. 5. The third field of the setup file records is a flag to indicate whether the automated dispatch system should monitor vehicle status updates to determine if a vehicle status update is late in being received, as discussed below in connection with Fig. 5. Finally, the fourth and fifth fields of the setup records indicate the specific AVL operating system and AVL port locking file, for the automatic vehicle locating system being used for the particular customer. This permits different automatic vehicle locating systems to be used for different customers, and potentially allows different fleets of vehicles to be dispatched with a single automated dispatching site through the use of different AVL systems and/or different AVL access ports.

The exception file illustrated in Fig. 3J includes, as noted below, the transport ID numbers for dispatch records which have been marked for human intervention, along with codes indicating the reasons that the records were marked for human intervention.

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The status limit file shown in Fig. 3K includes fields used to customize the performance of the automated dispatching system for a given customer. Most importantly, this file indicates the time limits for which a vehicle may remain at a given status during performance of an automatically dispatched task. The use of these fields will be discussed below. Also, this file may contain fields (not shown) indicating particular codes or keywords used by dispatcher as a shorthand for a vehicle status conditions (e.g., "vehicle is 20" meaning the vehicle is en route to the pickup), so that different codes or keywords may be used in screen displays and in communications for different fleets of vehicles.

Now turning to the detailed functions of the automatic dispatching processes 24, 26 and 28, Fig. 4A is an illustration of the dispatching processes 26. At the beginning of this process, the dispatch file 30 is opened 50 to permit evaluation of dispatch requests added to the dispatch file by call takers 12 or 14. Next, the dispatching process 26 extracts 52 individual records such as that shown in Fig. 3A from the dispatch file.

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The records from the dispatch file are processed sequentially in a loop beginning with step 54, at which a dispatch record is obtained from the results of the extracting step 52. This loop includes a sequence of steps illustrated in the remainder of Fig. 4A.

First, dispatching process 26 determines 56 if it has reached the end of the dispatch file. If the dispatcher has reached the end of the dispatch file, it returns to step 52 to re-extract records from the dispatch file and begin again at the beginning of the file. If the dispatching process 26 has not reached the end of the dispatch file, it proceeds to step 58 to determine whether the currently selected record is identified by the exception file 32 (this involves looking through the records {Fig. 3J} in the exception file 32 to locate any records having the same transport ID number as the current dispatch record). If the currently selected record is identified by the exception file 32, this indicates that there has been an unrecoverable error during automatic dispatching and monitoring of this record, and therefore it has been referred to human dispatchers 16 for handling. Therefore, if the current record is in the exception

file, the dispatching process returns to step 54 to get a new dispatching record.

5 If the dispatching record is not in the exception file, dispatching process 26 continues to step 60 and determines the status of the dispatch record by checking the second field of the record as shown in Fig. 3A. If the record has the status "prescheduled", indicated by a " " in the second field of the record, this indicates that the
10 transportation task described by the record has yet to be dispatched. In this case, the dispatching process 26 continues to step 62 to determine whether the record should be dispatched at the present time. If the record is not prescheduled, then as
15 illustrated in Fig. 3A, the record has either been dispatched or it has been cancelled or the job has been completely finished. In any of these cases, the record is no longer in need of dispatching, and therefore dispatching process 26 returns to step 54
20 to get a new dispatch record.

If a prescheduled record has been located which is not in the exception file, then the dispatching process 26 continues to step 62 at which it determines which company or customer the record
25 relates to.

Each dispatching process 26 is associated with a particular company or client and performs only dispatching for this one company or client and ignores any dispatching records in dispatch file 30 which relate to other companies or clients. The dispatching process 26 determines the company or client for which it is responsible from an automated dispatch setup file 48 which, as noted above with respect to Fig. 3I, indicates a company code that the automated dispatch processes are to operate upon.

Thus, in step 62, dispatching process 26 determines whether the currently selected record is for the current company. If not, the dispatching process skips the current record and will not dispatch it, and returns to step 54.

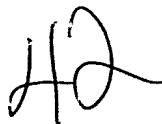
If the dispatching process 26 locates a record which is not in the exception file, is prescheduled, and is for the current company, then it determines if the job represented by the dispatch record should be initiated. If the dispatch record is marked "ASAP" in the fourth field, then the job should be dispatched immediately and the dispatching process 26 proceeds directly to step 66. Otherwise, the dispatching process determines if the time has

arrived to schedule the job. This is determined by comparing the current time to (a) the appointment time indicated in the fourth field of the dispatch record, (b) the lead time indicated in the fifth field of the dispatch record, and (c) the advance action time indicated in the second field of the setup file record for the current company as seen in Fig. 3I. If the appointment time, minus the lead time, minus the advance action time, is earlier than the current time, this indicates that the job should be initiated and a vehicle should be dispatched to meet the appointment, and the dispatching process 26 proceeds to step 66. If not, the dispatching process skips the record by returning to step 54.

If the current dispatch record is to be dispatched by the dispatching process 26 as determined in step 64, the dispatching process proceeds to step 66 and requests from the AVL system 18 a list of the N closest vehicles which are capable of handling the job. This is done by adding a automated dispatch request to the automated dispatch requests file 44, using the format shown generally in Fig. 3H and specifically in Fig. 3K-1.

To generate the request shown in Fig. 3K-1, dispatch process 26 uses the transport ID number

and the terminal number displaying the results of
 the dispatch process 26, or the processor number
 running the dispatch process 26, to generate a
 record ID as shown in Fig. 3K-1. The record ID is
 5 made unique by appending a three digit sequence
 number to the transport number and terminal number.
 In addition, dispatching process 26 extracts the
 transport type identified in the sixth field of the
 current dispatch record (see Fig. 3A) and places
 10 this transport type into the automated dispatch
 request in the third field, as shown in Fig. 3K-1.
 In addition, the dispatching process 26 retrieves
 the pickup address location from the tenth field of
 the dispatch record (Fig. 3A) and inserts this
 15 address information into the fourth, fifth, sixth
 and seventh fields of the automated dispatch request
 message shown in Fig. 3K-1. Finally, the
 dispatching process 26 identifies the number N of
 vehicles to be identified by the AVL system 18 in
 20 response to the request and inserts this number in
 the eighth field of the automated dispatch request
 as shown in Fig. 3K-1. For error correction
 purposes, a cyclic redundancy code (CRC) is added to
 the end of the automated dispatching request as
 25 shown at the end of Fig. 3K-1.



After placing the appropriately formatted request in the automated dispatch requests file 44, dispatching process 26 waits for a response to appear in the automated dispatch responses file 46.

5 (The mechanism for delivering the request to the AVL system 18, obtaining a response from AVL system 18, and placing this response in the automatic dispatch responses file 46, will be discussed below with reference to Figs. 6A and 6B. For the purposes of
10 Fig. 4A, this operation is completed in background and a response can be found in automated dispatch responses file 46 after a sufficient period of time.) When a response is found in automated dispatch responses file 46 (step 68), dispatching
15 process 26 proceeds to step 70 to evaluate the response received. (The response is deleted from the responses file once it has been read in step 68.)

In step 70, dispatching process 26 scans
20 the particular vehicles identified by the AVL response to locate a vehicle which is currently available. This is done by using the vehicle identification numbers returned from the AVL system to look for a record in the outbound vehicle file
25 36. If a record for the vehicle is found in the

outbound vehicle file, then the vehicle is not available and the dispatching process must check another vehicle.

If, after evaluating all of the vehicles identified by the AVL, no available vehicles are located, the dispatching process is unable to automatically dispatch the current job and must request human intervention. In this case, the dispatching process proceeds to step 80 at which it writes ~~the~~ an exception record to the exception file (Fig. 3J), indicating the transport ID number of the current dispatch record and a reason code indicating that the automated dispatching failed because of the absence of an available vehicle. Subsequently, a human dispatcher 16 will evaluate the dispatch record and take the appropriate action, for example, calling individual vehicles to ensure that they have in fact not completed their current assignments, or, calling the customer who requested the job to inform them that a vehicle will be dispatched late for the pickup. After writing a record to an exception file in step 80, dispatching process 26 moves on to the next record in the dispatch file by proceeding to step 54.

step 76, (now referring to Fig. 4B) this pager
counter is incremented. In step 78, dispatching
process 26 determines ^{it} if the counter has exceeded
the maximum number permitted. If the counter has
5 exceeded the maximum number the dispatching process
proceeds to step 80 (Fig. 4A) to write a record to
the exception file indicating the transport ID
number of the current dispatch record, and a reason
code indicating that the unrecoverable error was due
10 to a failure to communicate a page to the paging
service.

However, if the dispatching process has
not already paged the driver three times, it
proceeds to page the driver by referencing the
15 employee pager file shown in Fig. 3E to determine
the pager service and personal identification number
and telephone number used to page the employee who
is identified as the driver in field 8 of the
dispatch record. The pager service associated with
20 the employee in Fig. 3E is then used to select a
record from the pager service file 42 corresponding
to the pager service to which the employee
subscribes. The dispatching process 26 then reads
from the pager service file the pager service modem
25 number, the login ID, password, baud rate, word

length, stop bits and modem script that can be used
to access the employee's pager service. This
information is then used to control a modem to dial
the employee's pager service and transmit a message
5 to the pager service indicating that the employee
should be paged and notified of the new job assigned
to the employee.

If the paging operation is successful,
this is determined in step 82 and processing
10 proceeds to step 84 to begin generation and delivery
of a route. However, if the paging operation fails
for one reason or another, for example, because a
modem has failed, or because the line at the pager
service was busy when dialed, then dispatching
15 procedure 26 returns to step 76 to increment the
pager counter and make another attempt to page the
employee. After three attempts have been made, as
noted above, dispatching procedure 26 proceeds from
step 78 directly to step 80 and writes the record
20 into the exception file with an indication that
paging was not completed.

It should be noted that the most typical
cause of a failure to communicate a page to the
paging service is a faulty modem. There may,
25 however, be other problems not associated with the

modem. For this reason, in an alternative embodiment of the dispatching process, the process might proceed to the subsequent steps described below (including preparing a mobile terminal message to the vehicle) despite a failure to initiate a page of the vehicle. This redundant communication to the vehicle reduces the opportunity for a vehicle to miss receipt of a command.

It should also be noted that there are some paging services that will confirm receipt of a page at the pager; this kind of service can be important in vehicle dispatching since it prevents the driver from neglecting his/her duties and then claiming that the page was not received. If the paging service provides receipts, these might be detected and logged, for example by an additional background process having the sole purpose of collecting and logging receipts. Separating this function into a separate background process would avoid delays of the main processes while waiting for receipts. Such a background process could also perform step 104 discussed below, which awaits confirmation of an MDT message, and thereby further eliminate delay of the main process.

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5 If paging is completed successfully,
dispatching procedure 26 proceeds to step 84 at
which it initializes a route counter. This counter
is used in connection with a loop including steps
86-92, in which the dispatching procedure attempts
to generate a route for delivery to the selected
vehicle's driver.

10 In this loop, at step 86, dispatching
procedure 26 increments the route counter and at
step 88, dispatching procedure 26 determines whether
the route counter is greater than three (for
example). If the route counter is greater than
three, then the dispatching procedure 26 has made
three failed attempts to obtain a route from the AVL
15 system 18 and therefore determines that an
unrecoverable error has occurred during automated
dispatching. In this case, the dispatching
procedure proceeds to step 80 (Fig. 4A) and writes
the current transport ID number to an exception
20 record along with a reason code indicating that
automatic dispatching failed due to failure to
obtain a route from the AVL.

25 If however, the dispatching procedure has
not yet tried three times to obtain a route, the
dispatching procedure proceeds to step 90 and

initiates a request to be sent to the AVL system 18 to obtain a route for the driver to his assigned destination. To do this, the dispatching procedure 26 generates an automated dispatch request record having the general format illustrated in Fig. 3G, and stores this record into the automated dispatch request file 44. The specific format of the automated dispatch request is shown specifically in Fig. 3L-1. As seen in Fig. 3L-1, the route request includes the vehicle identification number for the vehicle selected to service the dispatch request, as well as the pickup address, city, state and zip code, and destination address, city, state and zip code. The pickup and destination addresses are obtained from the tenth and thirteenth fields in the dispatch record. In addition, the dispatching procedure 26 includes a cyclic redundancy code at the end of the request as shown in Fig. 3L-1.

The AVL system 18 includes algorithms to derive routing for drivers from identified pickup points to identified destination points. These algorithms will respond to the information in the request shown in Fig. 3L-1, and generate a response of the kind illustrated in Fig. 3L-2. This response includes a record identifier which is identical to

the record identifier in the request in Fig. 3L-1,
followed by a route string, which is a text string
indicating a list of street names, of streets to be
followed along a best route from the pickup address
5 to the destination address.

Under normal operation, the AVL system
will produce a response of the kind shown in Fig.
3L-2 within a predetermined period of time.
Accordingly, dispatching procedure 26 waits for this
10 predetermined period of time and then proceeds to
step 92 at which it determines if a route has been
received from the AVL system by scanning the
contents of the automated dispatch responses file 46
for a record having the same record ID as was
15 incorporated into the request of Fig. 3L-1. If no
response is received within this time period, then
automated dispatching procedure 26 re-requests a
route by returning to step 86. However, if a route
has been received, automated dispatching procedure
20 (after deleting the response from responses file 46)
proceeds to step 94 in which it creates a mobile
data terminal message for the selected vehicle,
incorporating the routing directions returned from
the AVL system, and also incorporating any
25 additional information of use to the driver which

might be incorporated into the dispatch file records when the dispatch file records are created by call takers 12 or remote data entry terminals 14.

One specific format for the mobile data terminal message is illustrated specifically in Fig. 3M-1. The mobile data terminal request incorporates much of the data in the dispatch record, including the transport identification number (field 4 of Fig. 3M-1) the date of service (field 5), the appointment time (field 6) and the transport type (field 7). Also included is patient information including the patient's name and phone number (fields 9 and 10); this information is obtained by referencing a patient information file (not shown) using the patient ID found in field 28 of the dispatch record.

Also included in the mobile data terminal records are the pickup city, street address, state and zip code and the destination street, city, state and zip code (fields 10-17). Next are four text fields for identifying the reason for the transport; this data is derived from fields 24-27 of the dispatch record and is entered by the call takers 12 or the remote data entry terminals 14 for relaying to the drivers. Finally, various vehicle status information is transferred from fields 16-23 of the

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dispatch records to fields 22-30 of the mobile data terminal record, including the time of the call requesting vehicle service, the time the crew was notified, the time the crew was dispatched, the time the crew was confirmed as en route, the time the crew arrived at the pickup site, the time the crew was confirmed as en route to their destination, the time that they arrived at their destination and the time that they became available. Finally, in field 30, the mobile data terminal message includes the route message for the route generated by the automated dispatching procedure in steps 90 and 92 as discussed above.

To transmit data to the mobile data terminal, dispatching procedure 26 follows a third loop which re-tries three times (for example) to transmit to the mobile data terminal via the AVL system. In the first step 96, dispatching procedure 26 initializes a mobile data terminal counter, and in a subsequent step 98, dispatching procedure 26 increments this counter. After step 98, dispatching procedure 26 determines whether the mobile data terminal counter is greater than three, and, if so, proceeds to step 80 to write a record to the exception file with a reason code indicating that

data transmission failed. In step 102, dispatching procedure 26 stores the mobile data terminal request record, as shown in Fig. 3M-1, into the automated dispatch requests file 44.

5 When the mobile data terminal information request has been placed into the automated dispatch requests file 44, a communications process 24 (discussed below with reference to Figs. 6A and 6B) forwards this request to the AVL system 18. The AVL system in response transmits the mobile data terminal information to the vehicle. The vehicle driver then confirms receipt of the information to the AVL system and the AVL system acknowledges this response to a communications process 24 which then places a mobile data terminal response record into the automated dispatch responses file 46. The format of this confirmation is shown in Fig. 3M-2. It essentially includes the same record ID number as was used in the mobile data terminal request of Fig. 3M-1. When this confirmation is received in step 104, dispatching process 26 deletes the response record from the responses file 46 and proceeds to step 106 to perform other dispatching activities. However, if this confirmation is not received after a predetermined period of time, dispatching process

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26 proceeds to step 80 (Fig. 4A) to write a record into the exception file 32 along with an indication that automated dispatching failed due to failure to reach the vehicle with a mobile data terminal message.

If a mobile data terminal message is successfully sent to the vehicle and a confirmation is received in step 104, then dispatching process 26 proceeds to step 106 in which it first stores the current time into the dispatch record as the time that the crew is dispatched (field 18).

Next, the dispatching procedure 26 generates a request to the AVL system to determine the latitude and longitude of the vehicle. This is done by generating a request having the format shown in Fig. 3N-1. This request essentially includes the transport number and vehicle ID number (fields 3 and 4) and the pickup and destination addresses (fields 5-12). The dispatching process 26 does not wait for a reply to this latitude-longitude request, because such a reply can take, in many cases, an inordinate amount of time to be returned. Rather, dispatching process 26 proceeds directly from step 106 to step 54, at which it gets a new dispatch record and begins processing the new dispatch record in the

manner discussed above. When the latitude and longitude is ultimately returned, this data is incorporated into the dispatching record by a communications process 24 as is discussed in further detail below in connection with Figs. 6A and 6B.

It will be noted that, as a result of the foregoing procedure, whenever a vehicle is dispatched, the vehicle is immediately thereafter delivered a suggested route for the requested transit. This not only assists the driver if the driver enters unfamiliar territory, but also is a way to ensure that the vehicles follow recommended best routing.

As is noted variously within this application, insurance and Governmental institutions have applied stringent requirements to ambulance carrier billing. One area that as yet is perhaps underregulated, however, is the mileage charged by the carrier. Governmental agencies could, and perhaps in the near future may, begin verifying the mileage charged by ambulance carriers by computing a route from the pickup to destination locations and comparing the mileage of the computed route to the mileage actually charged by the carrier. In the recent past, electronic invoicing for ambulance

services has been used increasingly; this trend also facilitates automatic electronic verification of mileage charges.

5 As noted above, it is one aspect of the present invention to automatically deliver, during vehicle dispatch, the exact route which will be used by Government or insurance agencies in verifying the mileage charges accumulated by the vehicle.

10 Furthermore, it is a related aspect of the invention to automatically perform such verification upon an ambulance service invoice to determine if the mileage charges on the invoice are within parameters set by a Government or insurance agency.

15 Referring now to Fig. 5, the operations of the vehicle monitoring process 28 can be discussed in particular detail. The vehicle monitoring process is responsible for tracking and monitoring the activities of vehicles once they have been dispatched by one of the dispatching processes 26.

20 It operates in generally the same overall fashion as the dispatching processes 26, by reviewing records in the dispatch file and acting on individual records when action appears to be needed.

25 Accordingly, in the first step 120, the vehicle monitoring process opens the dispatch file 30 and

then extracts 122 the dispatch records from the
dispatch file. Then, it gets 124 a particular
record from the dispatch file for review. If the
end of the dispatch file is reached in step 126, the
5 vehicle monitoring process returns to step 122 to
re-extract the records from the file and re-analyze
each record.

If a record has been found and the end of
file has not been reached, the vehicle monitoring
10 process 28 moves on to step 128 and determines
whether the current record is identified by a record
in the exception file 32. If the record is
identified in the exception file, this indicates
that the automated dispatching processes have found
15 an irreconcilable error and have referred the
dispatch job for human intervention. Accordingly,
the vehicle monitoring process returns to step 124
to get a new dispatch record.

If a record is found which is not in the
20 exception file, the vehicle monitoring process 28
proceeds to step 130 and determines the status of
the current dispatch record. If the record is
marked as dispatched, then the vehicle monitoring
process 28 is responsible for monitoring the status
25 and progress of the vehicle in servicing the record.

However, if the record status is not dispatched, then the vehicle monitoring process 28 is not concerned with the record and so returns to step 124 to get another record.

5 If a record is found which is not in the exception file and is dispatched, the vehicle monitoring process then proceeds to step 132 to determine if the record is a record for the company or client being serviced by the vehicle monitoring
10 process 28. This is determined by accessing the automated dispatch setup file 48 and, in particular, field 1 of that file as shown in Fig. 3I, which identifies the company code for the company currently being serviced by the automated
15 dispatching system. This company code is then compared with the transport ID number in the first field of the dispatch record as shown in Fig. 3A, which, as noted above, contains the company code. If the record is not related to the company
20 currently being serviced by the automated dispatching system, the vehicle monitoring process skips the record by returning to step 124 and getting a new record.

25 If, however, a record is found which is not in the exception file, is currently dispatched,

and is a job for the current company, the vehicle monitoring process proceeds to step 134 at which it determines whether the vehicle assigned to the record has reported itself as arrived at its pickup site. This is determined by checking the value in the time crew arrived at pickup field, which is the 20th field in the dispatch record as illustrated in Fig. 3A.

One of the important functions of the vehicle monitoring process is to determine if a vehicle is late for arrival at its pickup site and, if so, to warn the human dispatchers so that the appropriate action can be taken, for example, calling the customer to inform them that the vehicle will be late. Accordingly, if a vehicle has not reported as arrived, the vehicle monitoring process proceeds to steps 136 et seq. at which it determines if the vehicle is late.

Initially, the monitoring process 28 determines simply whether the vehicle is late for arrival at the pickup site. To do so, process 28 first determines 136 whether the record is scheduled for a specific appointment time, or ASAP service. If the record is scheduled for a specific appointment time, process 28 proceeds to step 137 to determine

if the current time is later than the appointment time. If the current time is later than the appointment time, process 28 proceeds to step 160 to write a record to the exception file 32 including a reason code indicating that automated dispatching failed because the vehicle was late to the pickup site.

If, however, at step 136, monitoring process 28 determines that the record is an ASAP request, then it proceeds to step 138 to determine whether the vehicle is late. In step 138, monitoring process 28 references the status limit file 44 to locate a status limit record (Fig. 3K) for the current company, and then reads the last field of this record to determine the "ASAP Limit" for the company. Then, process 28 compares the "ASAP Limit" to the difference between the current time and the time the ASAP request was received (as indicated in field 16). If more time than is indicated by the ASAP Limit has elapsed since the call was received, then the vehicle is considered late and monitoring process 28 proceeds to step 160 to write a record in the exceptions file.

If, however, in either steps 137 or 138, the vehicle is not determined to be late, then

monitoring process 28 proceeds to step 140. At step 140, monitoring process 28 determines whether the company it is servicing uses late status monitoring for its vehicles. This is determined by referencing the third field of the automated dispatch setup file which indicates whether status late activity is to be monitored or not. If status late activity is to be monitored, the vehicle monitoring process proceeds to step 142 at which it determines whether the vehicle is late in reporting its status.

To determine if a vehicle is late in reporting its status, the monitoring process reviews the status times identified in fields 17 through 23 of the dispatch record to locate the most recent status reported by the vehicle. The vehicle status will be one of "notified", "dispatched", "en route to pickup", "arrived at pickup", "en route to destination", "arrived at destination", or "available". Then, if the status is anything other than "available", monitoring process 28 determines how long the vehicle has been at its current status by comparing the current time to most recent time in fields 17 through 22 of the dispatch record. Finally, the monitoring process 28 references the status limit file 49 to locate the status limit

record (Fig. 3K) for the company to be serviced.
From this record, the monitoring process 28
determines the status limit for the current
vehicle's status. Finally, the time the vehicle has
5 been at its current status is compared to the
predefined limit for that status. If the vehicle
has exceeded the predefined limit, then the
monitoring process 28 proceeds to step 160 to write
an exception record identifying the dispatch record
10 and including a code indicating that the vehicle was
late in its status reports.

If the vehicle is not otherwise late, but
has not arrived (i.e., if the vehicle passes from
steps 134, 140, or 142), then further analysis of
15 the vehicle status may still be needed, because the
pickup may have been cancelled by the customer at
the pickup site, or the crew may have completed the
job and reported itself as available. Thus, in the
cases not discussed above, monitoring process 28
20 proceeds from steps 134, 140 or 142 to step 144, at
which it determines whether the vehicle has reported
itself as available. If not, monitoring process
proceeds to step 124 to obtain a new dispatch record
for processing.

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However, if the vehicle has reported
itself as available, monitoring process 28 proceeds
from step 144 to step 146, at which it marks the
status flag in the dispatch record (field 2) with an
5 "F" to indicate that the record has been finished.
This action will disable any further dispatching on
the dispatch record. At the same time, monitoring
process 28 deletes the record in the outbound
vehicle file 36 which associates the vehicle with
10 the dispatch record. Doing^{so} will allow the vehicle
to be recognized as available in step 70 of the
dispatching process 26, so that new tasks will be
assigned to the vehicle.

After these steps, the vehicle monitoring
15 process proceeds to step 148 and generates an
invoice record having the format shown in Fig. 3B,
using the information in the dispatch record, and
then writes the resulting invoice record to the
invoice file 34 for later use in generating invoices
20 for the services rendered by the vehicle. As can be
seen in Fig. 3B, the invoice record is generated by
transferring various fields from the dispatch record
into the new invoice record, including the transport
ID number and date of service, the vehicle
25 identification number and the driver and attendants'

employee numbers, the pickup and destination, the reasons for transport and billing information, and the time of various activities including the time the dispatch request was received, the time the crew was notified, dispatched, reported as en route to pickup, reported as arrived, reported as en route to its destination, and reported as available upon completion of the job. This detailed information and other information discussed above is important in satisfying insurance companies and federal or state agencies who demand detailed billing for compensation for transportation services.

The information in the invoice record may be used to print an invoice for mailing without further human intervention. Or, alternatively, the information might be used to generate and transmit an electronic invoice for services, leading to electronic payment, such that the entire transaction may be completed in a paperless manner without postage expense and handling, and the resulting delays and risks of loss. Another alternative is that the invoice records might be transmitted to customer sites (those having remote data entry persons 14 {Fig. 1}), to print an invoice at the customer site for delivery. Again, postage expense,

delay, and risk of loss are reduced or eliminated through direct electronic billing.

After generating a suitable invoice record, the vehicle monitoring procedure proceeds to step 150 at which it notifies the automatic vehicle locator system 18 that the vehicle is now available. The automatic vehicle locator system 18 retains internal tables indicating the status of each of the vehicles that it tracks, so that it may for example display the status of vehicles and their locations for a human dispatcher 16, or may produce reports of vehicle activity and vehicle availability.

The AVL system is notified of a new vehicle status by an automated dispatch request having the general format shown in Fig. 3G which is stored into the automatic dispatch requests file 44 and forwarded to the AVL system by the communications process as discussed below with reference to Figs. 6A and 6B. The specific format of the AVL transport status update is shown in Fig. 3O-1, and includes various information from the dispatching record, including the vehicle ID number, the transport ID number, the transport type, the appointment time, AVL system code for the new transport status, and the time at which this status

became effective, the driver and attendant employee numbers, the patient's name and the pickup and destination addresses.

5 After thus notifying the AVL that a vehicle is available, the vehicle monitoring process 28 returns to step 124 to get a new dispatch record.

10 It will be noted that the monitoring process described above relies on the vehicle operators to update their status regularly as they proceed through an assigned task. While this is an effective system for updating status, others might be used. For example, to determine whether a vehicle is en route, the monitoring process might compare two recent position readings for the vehicle to determine whether the vehicle is moving. To determine whether a vehicle is at the pickup or destination site, the monitoring process might simply compare the position of the vehicle to the position of the pickup and destination site. If such an approach is taken it is important to use highly accurate navigation tools, to discriminate a vehicle which is at the pickup site from a vehicle which is caught at a traffic light one block away from the pickup site. However, it is believed that these obstacles can be overcome and monitoring

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performed with even less human involvement than is described above.

Referring now to Figs. 6A and 6B, the communications process 24 can be more completely understood. The communications process reads requests from the automated dispatch request file 44, generates the appropriate communications to the AVL system 18, and also reads responses from the AVL system 18 and produces response records and stores them into automated dispatch responses file 46 so that the response records can then be evaluated by dispatching process 26 or vehicle monitoring process 28.

To initialize itself, the communications process 24 opens 170, a communications port to the AVL system 18 and also opens the requests file 44 and responses file 46.

The first part of the communications process illustrated in Fig. 6A is responsible for reading requests from the requests file 44 and generating communications to the AVL system 18 through the AVL port. Accordingly, in this portion of the communications process 24, the communications process reads a record from the request file (step

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172). If at step 174 the end of the request file is reached, the communications process proceeds to step 190 (Fig. 6B) to evaluate responses. If, however, the end of the file has not been reached, the

5 communications process proceeds to step 176 and writes the information from the current record to the AVL port. Then, the communications process performs a loop in which it waits for an

10 acknowledgment from the AVL system 18. This loop is repeated three times (for example) as determined by a counter which is initialized to zero in step 178. If an acknowledgment is received in step 180, the communications process then deletes the request record from the requests file (step 181), and

15 proceeds to step 190 (Fig. 6B) to handle responses from the AVL. However, if no response is received, the communications process increments the counter (step 182) and then determines whether the counter has been incremented above a value of two (step

20 184). If the counter has not yet reached a value of two in step 184, the communications process returns to step 180 to determine if an acknowledgment has yet been received.

However, if the counter exceeds the value

25 of two (for example), then the AVL communication has

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failed. In this situation, the communications process proceeds to step 186 in which it generates an exception record based on the request and then writes the exception record to the exception file (step 188) to refer the situation to a human dispatcher 16. The exception record includes a code indicating that automated dispatch failed in attempting to communicate with the AVL.

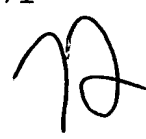
After steps 174, 181 or 188, the communications process arrives at step 190 of Fig. 6B. At this step and in the subsequent steps, the communications process attempts to read information from the AVL system 18 and prepare the appropriate response records for use by the dispatching process 26 or vehicle monitoring process 28. If the AVL port times out 192 before a response is received, then the communications process simply returns to step 172 (Fig. 6A) to locate records in the requests file, if any, and act on those records.

If, however, information is received from the AVL port, the communications process 24 evaluates the information received from the AVL port to determine what kind of message is being received and to take the appropriate action. For example, if a request for status information is received, this

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is determined in step 194 and handled in steps 196 and 198. If mobile data terminal information is received, this is determined in step 197 and handled in steps 199-204. If an updated status is received from a vehicle, this is determined in step 206 and handled in steps 208-214. If a latitude and longitude for a vehicle is returned from the AVL, this is determined in step 216 and handled in steps 218-222. Other responses from the AVL are handled in step 224.

A request for status information may be generated unilaterally by the AVL to update its internal tables of vehicle status information. Such a request is received by the communications process in the form shown in Fig. 3P-1. The request includes a record identification number which is equal to the vehicle identification number for which the status is requested. To respond to this request, the communications process accesses the dispatch record for the job currently being handled by the vehicle identified by the vehicle ID number in the request for status information. This is done by referencing the outbound vehicle file 36 to determine the transport ID number associated with the vehicle ID number. Then, this transport ID



number is used to retrieve the dispatch record from the dispatch file 30 having this transport ID number. Then, in step 198 this dispatch record is used to generate a response to the AVL identifying the status of the vehicle. This response takes the form illustrated in Fig. 3P-2 and includes the vehicle identification number, the transport record identifier, the type of the vehicle, its current appointment time, its status and the time that its status was last updated, the driver and attendant employee numbers, the patient's name and the pickup and destination addresses. This output record is then returned to the AVL system 18 by proceeding directly to step 176 in Fig. 6A and writing the contents of this record to the AVL port.

Mobile data terminal information may be transmitted unilaterally from the AVL system 18, in response to an entry of updated information into a mobile data terminal by a vehicle driver. When the vehicle driver transmits amendments to mobile data terminal information, these amendments are received by the AVL system 18 and then forwarded to the communications process 24. The format of the information received from the mobile data terminal is the same as the format of the information

transmitted to a mobile data terminal as seen in Fig. 3M-1, with the exception that a route message is not returned from the mobile data terminal. The resulting record format is shown in Fig. 3Q-1.

5 To respond to mobile data terminal information received from the AVL, the communications process reads the transport identification number from the fourth field in the mobile data terminal information and uses this
10 identifier to locate the dispatch record associated with the transport identification number in the dispatch file 30. Then the communications process reads this dispatch record (step 199) and updates the fields of the dispatch record in response to the
15 mobile data terminal information received from the AVL system ¹⁸19. For example, the ambulance crew may have updated ¹the address of the pickup or destination, or may have added reasons for the transport or diagnostic information. After updating
20 the dispatch fields 200, the communications process writes 202 the amended dispatch record into the dispatch file 30. Finally, the communications process acknowledges receipt of the transmission from the AVL system by generating a brief receipt
25 message as illustrated in Fig. 3Q-2. This message

includes the record ID of the incoming mobile data terminal message and the vehicle identification number. The acknowledge message of Fig. 3Q-2 is then transmitted to the AVL system by proceeding
5 directly to step 176 of Fig. 6A.

Updated status information may be received from vehicles unilaterally at many points during their performance of assigned duties. For example, when the vehicle wishes to confirm that it is en
10 route to its pick-up, it may use its mobile data terminal to send a status update message to the automated dispatch system. Furthermore, when the vehicle becomes available, it may send a different status message. These status messages are received
15 by the AVL system and then forwarded to the automated dispatch system and received by communications process 24.

Status messages may be prepared by typing information to the mobile data terminal. Or the
20 mobile data terminal may be voice activated and controlled so that the driver and/or crew can control it hands-free while driving.

When a received updated status message is identified in step 206, the communications process
25 first reads the updated status message to determine

the associated dispatch record. The format of an updated status message is shown in Fig. 3R-1. The format includes a record identifier which includes the transport identification number and vehicle identification number. This record identifier is used to locate and read the dispatch record based on the transport identification number. Next, the communications process 24 uses the status level identified in the third field of the status change message to update the status fields (fields 18-23 of Fig. 3A) in the dispatch record (step 210). Next, the dispatch record with updated status fields is written back to the server 10 with the updated status information. Finally, an acknowledgement message of the form shown in Fig. 3R-2 is generated by the communications process and delivered to the AVL system by proceeding directly to step 176 of Fig. 6A.

Another type of message which may be regularly received by the automated dispatch system is the latitude and longitude of a vehicle, as is requested by the dispatching process 26 in step 106. In response to this request, the AVL system ¹⁸~~19~~ will return a response having the format shown in Fig. 3N-2. The response includes a record identifier

indicating the transport number, terminal number and
sequence number supplied in the request shown in
Fig. 3N-1. Furthermore, the response indicates the
latitude and longitude of the pickup address and
5 destination address supplied in the request message.

In handling a latitude/longitude response,
the communications process first uses the transport
identification number in the response to locate the
dispatch record and to read 218 this dispatch
10 record. Next, the communications process updates
220 the latitude and longitude fields (fields 11-12
and 14-15) in the dispatch record. Finally, the
communications process writes 222 the amended
dispatch record so that the latitude/longitude
15 information is available for later use. Then, the
communications process returns to step 172 to begin
evaluation of records in the requests file 44.

Additional forms of responses may be
handled by communications process 24. In
20 particular, the response from the AVL which
indicates the closest vehicles requested by a
dispatching process (Fig. 3K-2) is handled by
writing a corresponding record to the responses file
46 in step 224. Similar actions are taken to store
25 a response of the kind shown in Fig. 3L-2 which

indicates a route for a vehicle to a destination.
Also, step 224 stores responses of the kind shown in
Fig. 3M-2 which indicate a confirmation of a MDT
message.

5 The communications process of Figs. 6A and
6B may also be used to transmit and receive "manual"
message packets, i.e., manually generated, non-
standard messages which are exchanged between a
human dispatcher 16 and the driver of a vehicle 20,
10 particularly during exceptional situations. To
perform such transmissions, a dispatcher 16 may use
software to generate a suitable request message and
store this request message in the automated dispatch
request file 44. Furthermore, a driver may type (or
15 voice-enter) a generic text message into a message
data terminal and transmit it to the AVL system
which will in response produce a generic text
message that may be stored by communications process
24 in step 224 for review by a dispatcher 16. Thus,
20 any software used by the dispatcher to monitor
exception conditions and respond to those
conditions, may use the automated data transfer
capabilities of the communications process 24 to
facilitate these communications.

While the present invention has been illustrated by a description of various embodiments and while these embodiments have been described in considerable detail, it is not the intention of the applicants to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art.

For example, one might include a field in each record of the automated dispatch file (see Fig. 3I), to indicate those customers for whom automated dispatching is to be performed. Doing so would add flexibility by, for example, permitting management to make a policy decision not to perform automated dispatching for a given customer or contract. To implement this, the dispatching process 26 illustrated below in Fig. 4A would need to be modified so that, in the initial series of tests 56-62, the dispatching process determines whether automated dispatching was enabled for the current company, and if not, immediately moves to step 80 to write the current record in the exceptions file for manual dispatching.

Furthermore, methods and apparatus described herein could be used for any kind of

vehicles, not limited for example to taxis and
ambulances. For example, shipping traffic, whether
by land (e.g., semitrailers), sea (e.g., freighters)
or air (e.g., cargo planes) could be dispatched and
5 monitored under principles of the present invention.
Moreover, land, sea or air traffic control could in
general be performed in a fully automated manner
using principles of the present invention. One
particularly fruitful area is the ground traffic
10 control of ground vehicles and airplanes at airport
facilities; typically movements of ground vehicles
and airplanes on the airport tarmac are controlled
by human dispatchers using their visual information
and/or radar systems, which system is prone to
15 failures such as recently experienced at the Denver
airport.

Data gathered from vehicles might not be
limited to the vehicles position and status; in
addition, the system might gather information on
20 whether the vehicle is moving, the velocity of the
vehicle, whether the vehicle is braking, the fuel
usage of the vehicle, whether emergency signals of
the vehicle are operating, and whether the engine is
idling. This data could be used to determine, for
25 example, whether the vehicle is caught in traffic or

